

POPULATION CHARACTERISTICS AND EXPLOITATION OF THE  
IMPORTANT MARINE PRAWNS OF  
AMBALAPUZHA, KERALA

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ABSTRACT

The prawn fishery of Ambalapuzha is carried out by trawl nets from October to May, and by the indigenous gear from June to September when the extensive mud-bank formations occur in this region. The fishing ground extends from 4 to 40 metres depth zone, the shallow water (4 to 10 metres) zone being fished by the non-mechanised boats and the 10-40 metres depth zone by the mechanised vessels. The fishery is supported by three species of penaeid prawns, namely, *Metapenaeus dobsoni* (Miers), *Parapenaeopsis stylifera* (H. Milne Edwards) and *Penaeus indicus* H. Milne Edwards. The population of all these species is predominantly composed of females, although in *M. dobsoni* and *P. stylifera* males are found in higher proportion than females in the lower size groups. The preponderance of females in the population and the disparity in the sex ratios in different size groups have been attributed to the reproductive activities and differential growth rate of the sexes. The males and females of *M. dobsoni*, *P. stylifera* and *P. indicus* respectively attain a length of 97|115; 91|98 and 158|138 mm at the end of first year of life and 122|138; 117|123 and 189|181 mm at the end of second year, and each of the species lives for about 2 years. Highest difference in the growth rate between the sexes is observed in *P. indicus* and the lowest in *P. stylifera*. The bulk of the commercial fishery of *M. dobsoni* and *P. stylifera* is supported by the 7-12 month old prawns and that of *P. indicus* by the 7-18 month old prawns. Majority of the spawning population in the former two species is composed of 0 year old females and in the latter species by the one-year old females. The estimated annual total mortality rate in the males of *M. dobsoni* and *P. stylifera* is found to be about 4, while in the females of these species as well as in the males of *P. indicus* it is about 3. The lowest mortality rate is obtained for the females of *P. indicus*.

The monthly landings of the different species and the effort expended show wide fluctuations. However, the catch per unit of effort and the mean size of the different species do not show a regular declining trend. It has been found that the successful spawning by the surviving spawners and the subsequent recruitment of younger prawns into the fishable stock greatly influence the fluctuations in the landings. Ecological changes brought out by the physico-chemical disturbances in the environment and their influence on prawn landings are discussed.

### INTRODUCTION

Ambalapuzha (Lat. 5°10'N; Long. 75°80'E), situated in the central part of the Kerala coast, is about 80 kilometres south of Cochin. This part of the coast is well known for the lucrative inshore fishery as well as the mud-bank ('chakara') prawn fishery which normally occurs every year during the south-west monsoon period. In recent years, trawling for prawns in the offshore fishing grounds of Ambalapuzha has also been introduced, and consequently, the area has developed into an important prawn fishing centre of the Kerala coast. Except for the contribution by George (1961) on the indigenous prawn fishery of the adjoining Alleppey coast, no information is available on the prawn fishery of the region. The present paper embodies the results of the studies carried out from 1971 to 1973 on the population characteristics and exploitation of the commercially important prawns of this area as a part of the overall investigations under the All India Co-ordinated Research Project for 'Studies on marine prawn biology and resources'.

### MATERIAL AND METHODS

From December 1971 to December 1973, the fish landing centre was regularly visited twice a week to collect the fishery data and catch samples. To estimate the monthly species-wise catch, the average weight of catch per gear unit on an observation day was multiplied by the number of units in operation on that day; the total for all the observation days was then obtained and raised to the total number of actual fishing days in that particular month to get the monthly weight. The total fishing effort (expressed in terms of actual fishing hours) for each gear was estimated similarly.

Prawn samples from each gear were analysed for sex, weight, number, total length (measured from tip of rostrum to posterior end of telson), and maturity stages of females. The number landed was estimated from the weight of catch by the following method. The length measurements were grouped in 5 mm size intervals and the number of prawns in each size group estimated by using sample weight and the estimated total catch of the species for the day by the gear. These data were then raised to the monthly catch weight to get the number of prawns landed during the particular month. The sex ratio was estimated on the basis of the total monthly catch in numbers. The density of prawns on the grounds was expressed either in terms of weight or number per unit of effort.

The methods employed for age and growth studies and for estimating the mortality rates are given in the concerned sections.

### THE FISHERY

The prawn fishery of Ambalapuzha is carried out throughout the year. Fishing by trawl net usually commences by October and extends till May. The

main crafts used during this period are the shallow draught mechanised boats powered by 10-40 h.p. engines; the number of boats is about 300. Most of the boats undertake daily cruises and fishing is conducted in the depth range of 10 to 40 metres, where the bottom is muddy. Shrimp trawls of 18.5 metres foot-rope length with mesh size of 20 mm at the cod end are the most common gears operated by these boats.

From June to September, fishing is confined to nearshore waters and the indigenous plank-built boat and the boat-seine, locally called 'Thangu vala' are employed. Although normally about 250 numbers of these units are operating from this area, during the peak mud-bank fishing season as many as 3,100 additional fishing units brought in from the adjoining fishing villages are put in for operation.

When the trawl fishery commences after the rainy season, the fishing is carried out for a brief period in the northwest grounds and then in the south-southwest grounds at 14-30 metre depth zone. As the season advances, the fishing is shifted again to the slightly deeper grounds (20-35 metres) in the north-northwest. Just before the commencement of the rainy season (April-May) the trawlers generally operate at 10-25 metre depth zone.

The prawn fishery of the centre is mainly supported by three species of penaeid prawns, namely, *Metapenaeus dobsoni* (Miers), *Parapenaeopsis stylifera* (H. Milne Edwards) and *Penaeus indicus* (H. Milne Edwards). The former two species contribute to the bulk of the fishery. Stray catches of *M. affinis* (H. Milne Edwards) and *M. monoceros* (Fabricius) are occasionally encountered during February-March period.

#### POPULATION CHARACTERISTICS

##### *Sex ratio*

In *M. dobsoni* the overall male to female sex ratio was found to be 1:1.9; females predominating in the catches of all the months except in December 1971 and July 1972 (Table 1). The males were generally seen in higher proportions than females in the lower size groups up to 71-75 mm. In the higher size groups, the ratio of females increased and above 101-105 mm size, the population was almost entirely composed of female prawns (Table 2).

In the population of *P. stylifera*, the sex ratio of male to female was 1:1.3. In the monthly sex ratio distribution, males were dominant in December 1971, March, May, November and December 1972. Size-wise distribution of sex ratio showed preponderance of males in the size group below 81-85 mm, while in the larger size groups females were in far excess of males (Table 2). In April-May and in September, the females were found to be dominating in the lower size groups also.

TABLE 1. Monthly sex ratio distribution of three species of penaeid prawns at Ambalapuzha for the period December, 1971 to June, 1973.

| Month         | <i>M. dobsoni</i> |        | <i>P. stylifera</i> |        | <i>P. indicus</i> |        |
|---------------|-------------------|--------|---------------------|--------|-------------------|--------|
|               | Male              | Female | Male                | Female | Male              | Female |
| December 1971 | 69.7              | 30.3   | 78.1                | 21.9   | —                 | —      |
| January 1972  | 34.3              | 65.7   | 48.9                | 51.1   | 15.4              | 84.6   |
| February      | 20.9              | 79.1   | 37.9                | 62.1   | 37.8              | 62.2   |
| March         | 17.2              | 82.2   | 64.1                | 35.9   | 45.5              | 54.5   |
| April         | 33.8              | 66.2   | 21.2                | 78.8   | 31.2              | 68.8   |
| May           | 34.3              | 65.7   | 58.8                | 41.2   | 49.0              | 51.0   |
| June          | —                 | —      | —                   | —      | —                 | —      |
| * July        | 71.8              | 28.2   | —                   | —      | 30.3              | 69.7   |
| * August      | 38.0              | 62.0   | —                   | —      | 34.3              | 65.7   |
| * September   | 37.6              | 62.4   | 34.1                | 65.9   | —                 | —      |
| October       | 36.0              | 64.0   | 46.0                | 54.0   | 29.0              | 71.0   |
| November      | 27.0              | 73.0   | 67.6                | 32.4   | 20.3              | 79.7   |
| December      | 19.6              | 80.4   | 67.6                | 32.4   | 26.3              | 73.7   |
| January 1973  | 29.4              | 70.6   | 40.7                | 59.3   | 25.8              | 74.2   |
| February      | 29.8              | 70.2   | 38.9                | 61.1   | 17.3              | 82.7   |
| March         | 43.3              | 56.7   | 36.8                | 63.2   | 27.8              | 72.2   |
| April         | 31.6              | 68.4   | 37.4                | 62.8   | 29.9              | 70.1   |
| May           | 48.6              | 51.4   | 30.1                | 69.9   | 45.0              | 55.0   |
| * June        | 46.3              | 53.7   | 42.3                | 57.7   | —                 | —      |

\* Non-mechanised boats with 'Thanguvala'.

TABLE 2. Size-wise sex ratio distribution of three species of penaeid prawns at Ambalapuzha during different periods.

(Sex ratio is given as number of females per unit male)

| Size in mm | 1st period †<br>December, 1971<br>to May, 1972 | 2nd period ††<br>June, 1972 to<br>September, 1972 | 3rd period †<br>October, 1972<br>to May, 1973 | 4th period ††<br>June, 1973 |
|------------|--|---|---|-----------------------------|
|            | <i>M. dobsoni</i>                              |   |   |                             |
| 46-50      | —  | —   | —   | —                           |
| 51-55      | 3.1  | —   | 0.1   | *                           |
| 56-60      | 0.1  | 0.3   | 0.3   | 1.5                         |
| 61-65      | 0.7  | 0.2   | 0.7   | 0.8                         |
| 66-70      | 0.4  | 0.5   | 0.6   | 0.5                         |
| 71-75      | 0.4  | 0.1   | 0.6   | 0.4                         |

† Trawl Fishery

\* Female only

— No specimen

†† Non-mechanised boats with 'Thanguvala'

† Male only

| Size in mm           | 1st period †<br>December, 1971<br>to May, 1972 | 2nd period ††<br>June, 1972 to<br>September, 1972 | 3rd period †<br>October, 1972<br>to May, 1973 | 4th period ††<br>June, 1973 |
|----------------------|--|---|---|-----------------------------|
| 76-80                | 3.1  | 0.5   | 0.4   | 0.4                         |
| 81-85                | 1.1  | 1.2   | 7.5   | 0.8                         |
| 86-90                | 3.5  | 0.1   | 5.2   | 1.3                         |
| 91-95                | 14.8   | 0.1   | 2.5   | 6.8                         |
| 96-100               | 3.7  | 0.5   | 44.6  | *                           |
| 101-105              | 6.5  | 9.9   | * .....                                       | *                           |
| 106-110              | 11.5   | 1.8   | *   | *                           |
| 111-115              | *  | *   | *   | —                           |
| 116-120              | *  | *   | *   | —                           |
| <i>P. styliifera</i> |  |   |   |                             |
| 46-50                | —  | —   | ‡   | —                           |
| 51-55                | 0.6  | 1.9   | 1.1   | *                           |
| 56-60                | 0.3  | 1.1   | 0.5   | 9.6                         |
| 61-65                | 0.8  | 0.2   | 0.4   | 6.1                         |
| 66-70                | 1.3  | 0.7   | 1.4   | 8.7                         |
| 71-75                | 0.4  | 1.2   | 0.5   | 1.3                         |
| 76-80                | 0.5  | 1.9   | 2.4   | 0.7                         |
| 81-85                | 0.7  | 3.0   | 2.8   | 2.2                         |
| 86-90                | 0.9  | 2.3   | 2.4   | 0.7                         |
| 91-95                | 6.1  | 7.0   | 10.4  | 8.4                         |
| 96-100               | 4.5  | *   | 7.9   | 0.1                         |
| 101-105              | 17.9   | *   | 18.7  | *                           |
| 106-110              | *  | *   | 4.6   | *                           |
| 111-115              | 8.7  | —   | —   | —                           |
| 116-120              | *  | —   | *   | —                           |
| 121-125              | *  | —   | —   | —                           |
| <i>P. indicus</i>    |  |   |   |                             |
| 91-95                | —  | —   | ‡   | —                           |
| 96-100               | 0.3  | —   | *   | —                           |
| 101-105              | 15.7   | —   | *   | —                           |
| 106-110              | 2.3  | —   | 0.6   | —                           |
| 111-115              | 0.5  | 9.7   | 1.9   | —                           |
| 116-120              | 4.5  | *   | 2.7   | —                           |
| 121-125              | 3.3  | 45.6  | 5.4   | —                           |
| 126-130              | 0.9  | 142.0   | 5.8   | —                           |
| 131-135              | 0.7  | 106.4   | 2.2   | —                           |
| 136-140              | 1.1  | 30.2  | 3.9   | —                           |
| 141-145              | 2.8  | 8.0   | 5.3   | —                           |
| 146-150              | 1.6  | 4.7   | 2.6   | —                           |
| 151-155              | 1.3  | *   | 2.5   | —                           |
| 156-160              | 2.3  | 4.0   | 3.8 *   | —                           |
| 161-165              | 13.9   | 5.0   | 0.6   | —                           |
| 166-170              | *  | *   | 6.2   | —                           |
| 171-175              | —  | —   | 24.9  | —                           |
| 176-180              | —  | —   | 67.8  | —                           |

In *P. indicus* the overall male to female sex ratio was 1:2.2. As in the case of the preceding two species, females were predominant in the catches of all the months (Table 1). Up to the 141-145 mm size group, the sex ratio distribution showed little consistency as the males and females were found in varying proportions in different months. In the size group above 146-150 mm, females were generally encountered in greater numbers than males, except in March 1972.

#### *Size composition*

The size of *M. dobsoni* ranged from 52 mm to 110 mm in males and from 51 mm to 121 mm in females. In the trawl fishery, the males were mainly composed of the 66-95 mm size group (Table 3). Smaller prawns below 60 mm size were encountered from October to May, while the larger prawns above 95 mm size were abundant in the catches of April-May 1973. In females, majority of prawns belonged to 66-100 mm size, but those above 100 mm size were also caught in appreciable numbers from October to May. Small sized females below 60 mm were represented in the catches landed in February, May, October and December 1972 and again during February-May 1973.

In the mud-bank fishery of July, the principal size of the species was found at 81-100 mm for males and at 91-115 mm for females.

The monthly mean size of the males of *M. dobsoni* varied between 64.5 mm and 91.5 mm and that of females between 73.6 mm and 98.5 mm. The lowest mean size for males was recorded in November 1972, while for females it was in January. The highest mean size for both the sexes was observed in July. There was little consistency in the distribution and progression of mean sizes in different months, indicating irregular pattern of incursion of prawns belonging to different size groups into the fishery and their wide fluctuations in abundance.

The size of *P. stylifera* ranged from 51 mm to 109 mm in males and from 52 mm to 123 mm in females. In the commercial catches, majority of males belonged to 61-90 mm length group (Table 4). In April 1973, appreciable quantities of smaller prawns below 60 mm size as well as those above 90 mm were also landed. In females, the dominant size group in the fishery was found to vary between 66 mm and 100 mm size. However, in February 1972 and from February to April 1973 large numbers of prawns belonging to the smaller as well as larger size groups were also seen to contribute to the catches.

The mean size of *P. stylifera* (Table 4) varied between 70.3 mm and 90.9 mm in males and between 74.6 mm and 99.4 mm in females. The lowest mean size for males was observed in April 1972 and for females in June 1973. The highest mean size was recorded in April 1973 for both the sexes. As in the case of *M. dobsoni* the distribution of mean size in different months showed no definite pattern.

The catch of *P. indicus* was composed of individuals ranging in size from 96 mm to 175 mm in males and from 97 mm to 180 mm in females. The trawl fishery for the species in January 1972 was mainly contributed by the prawns belonging to the size group between 96-100 mm and 136-140 mm (Table 5), but as the season advanced, a gradual incursion of larger prawns was noticed and in May the dominant size groups were found at 161-165 mm in males and 151-155 mm in females. After the rainy season when the trawl fishery commenced again in October 1972, the dominant size of males was at 146-150 mm. In the subsequent months till April, the modal size of the species was seen varying between 131-135 mm and 146-150 mm. However, in May 1973, large size males with the modal size at 161-165 mm were abundant. The principal size of the females during the period was found between 136-140 mm and 150-160 mm.

During the beginning of the mud-bank fishery in July, males were poorly represented in the catch, while the female population was consisted of relatively smaller sized prawns (106-145 mm), but in August, both males and females were more or less in the same size group at 121-165 mm.

The mean size of *P. indicus* in the trawl fishery was varying from 113.0 mm to 154.6 mm in males and 117.6 mm to 169.3 mm in females, whereas, in the mud-bank fishery of July and August, it was 113.0 mm and 145.4 mm for males and 130.9 mm and 150.2 mm for females. In the case of males, a gradual progression of mean size from 125.8 mm in January 1972 to 145.7 mm in May 1972 was observed. A similar progression of mean size from 141.8 mm to 145.7 mm during March-May 1973 period was also discernible. However, in the case of females there was no regularity in the distribution of mean size in different months.

#### *Age and Growth*

In order to study the age and growth, the main and the subsidiary size modes found in the monthly length frequency distribution of *M. dobsoni* (Table 3), *P. stylifera* (Table 4) and *P. indicus* (Table 5) were plotted and their progression in the subsequent months were traced (Fig. 1). The initial size mode and the month in which it was recognised, the final size mode and the month up to which the initial mode was traced, duration and the growth increment, and the average rate of growth per month for each sex of the above species are given in Table 6. Among the three species, relatively higher growth rate is observed in *P. indicus*, the estimated average being at 9.8 mm and 7.2 mm per month for males and females respectively. In the size range encountered in the fishery, *M. dobsoni* grows at an average rate of 6.2 mm in males and 7.3 mm in females, while in *P. stylifera* it is about 5 mm in both the sexes.

TABLE 3. *Size distribution of M. dobsoni during the*

(Figures denote number of

| Size in<br>(mm)   | Months       |              |      |      |      |      |      |      |      |       |
|-------------------|--------------|--------------|------|------|------|------|------|------|------|-------|
|                   | 1971<br>Dec. | 1972<br>Jan. | Feb. | Mar. | Apr. | May  | June | July | Aug. | Sept. |
|                   | Male         |              |      |      |      |      |      |      |      |       |
| 51-55             | —            | —            | 1    | —    | —    | —    | —    | —    | —    | —     |
| 56-60             | 9            | —            | 6    | 2    | —    | 14   | —    | —    | —    | 13    |
| 61-65             | 9            | 2            | 40   | 4    | 1    | 11   | —    | 1    | 1    | 21    |
| 66-70             | 9            | 2            | 104  | 49   | —    | 26   | —    | 3    | —    | 28    |
| 71-75             | 9            | 10           | 8    | 97   | 16   | 62   | —    | 5    | 1    | 101   |
| 76-80             | 9            | 1            | 45   | 92   | 8    | 59   | —    | 22   | 1    | 61    |
| 81-85             | 82           | 9            | 57   | 58   | 12   | 82   | —    | 249  | 2    | 68    |
| 86-90             | 63           | 7            | 19   | 12   | 4    | 26   | —    | 751  | —    | 13    |
| 91-95             | 100          | 1            | 19   | 8    | 4    | 23   | —    | 1067 | —    | 7     |
| 96-100            | 73           | —            | 6    | 6    | —    | 2    | —    | 262  | —    | —     |
| 101-105           | 27           | —            | 2    | —    | —    | —    | —    | 37   | —    | —     |
| 106-110           | 9            | —            | —    | —    | —    | —    | —    | 93   | —    | —     |
| Mean size<br>(mm) | 89.3         | 80.1         | 74.3 | 77.0 | 79.7 | 78.2 | —    | 91.5 | 78.0 | 75.9  |
|                   | Female       |              |      |      |      |      |      |      |      |       |
| 51-55             | —            | —            | 5    | —    | 2    | —    | —    | —    | —    | —     |
| 56-60             | —            | —            | 5    | —    | —    | 30   | —    | —    | —    | 7     |
| 61-65             | —            | —            | 13   | 4    | —    | 69   | —    | —    | —    | 14    |
| 66-70             | 9            | —            | 51   | 10   | 2    | 53   | —    | 1    | —    | 6     |
| 71-75             | 27           | 2            | 42   | 19   | 2    | 53   | —    | 1    | —    | 117   |
| 76-80             | —            | 6            | 86   | 49   | 15   | 57   | —    | 3    | —    | 163   |
| 81-85             | 9            | 23           | 141  | 85   | 11   | 75   | —    | 29   | 2    | 115   |
| 86-90             | 9            | 32           | 84   | 111  | 25   | 134  | —    | 45   | 2    | 46    |
| 91-95             | 27           | 16           | 59   | 1255 | 9    | 94   | —    | 87   | 2    | 19    |
| 96-100            | 55           | 8            | 40   | 44   | 5    | 31   | —    | 139  | —    | —     |
| 101-105           | 27           | 4            | 25   | 30   | 2    | 46   | —    | 373  | —    | —     |
| 106-110           | 9            | 1            | —    | 5    | —    | 17   | —    | 167  | —    | —     |
| 111-115           | —            | —            | —    | 4    | —    | 3    | —    | 130  | —    | —     |
| 116-120           | —            | —            | —    | —    | —    | —    | —    | 18   | —    | —     |
| Mean size<br>(mm) | 91.7         | 73.6         | 79.7 | 91.6 | 86.8 | 89.1 | —    | 98.5 | 89.0 | 83.8  |





TABLE 4. *Size distribution of P. stylifera during the*  
(Figures denote number of

| Size in<br>(mm)   | Months |      |      |      |      |      |      |      |      |       |   |      |
|-------------------|--------|------|------|------|------|------|------|------|------|-------|---|------|
|                   | 1971   |      | 1972 |      |      |      |      |      |      |       |   |      |
|                   | Dec.   | Jan. | Feb. | Mar. | Apr. | May  | June | July | Aug. | Sept. |   |      |
|                   | Male   |      |      |      |      |      |      |      |      |       |   |      |
| 46-50             | —      | —    | —    | —    | —    | —    | —    | —    | —    | —     | — | —    |
| 51-55             | —      | 4    | 9    | 1    | —    | —    | —    | —    | —    | —     | — | 30   |
| 56-60             | —      | 2    | 14   | 4    | —    | —    | —    | —    | —    | —     | — | 56   |
| 61-65             | 4      | 2    | 14   | 8    | 2    | —    | —    | —    | —    | —     | — | 229  |
| 66-70             | 4      | 5    | 30   | 16   | 1    | —    | —    | —    | —    | —     | — | 309  |
| 71-75             | 4      | 25   | 130  | 47   | 2    | —    | —    | —    | —    | —     | — | 598  |
| 76-80             | 48     | 63   | 120  | 21   | 1    | 1    | —    | —    | —    | —     | — | 54   |
| 81-85             | 137    | 70   | 104  | 37   | —    | 1    | —    | —    | —    | —     | — | 590  |
| 86-90             | 22     | 23   | 101  | 29   | —    | —    | —    | —    | —    | —     | — | 288  |
| 91-95             | —      | 2    | 15   | 14   | —    | —    | —    | —    | —    | —     | — | 51   |
| 96-100            | —      | 1    | 12   | 1    | —    | —    | —    | —    | —    | —     | — | —    |
| 101-105           | —      | —    | 2    | —    | —    | —    | —    | —    | —    | —     | — | —    |
| 106-110           | —      | —    | —    | —    | —    | —    | —    | —    | —    | —     | — | —    |
| Mean size<br>(mm) | 81.5   | 79.5 | 76.7 | 80.5 | 70.3 | 78.1 | —    | —    | —    | —     | — | 76.2 |
|                   | Female |      |      |      |      |      |      |      |      |       |   |      |
| 46-50             | —      | —    | —    | —    | —    | —    | —    | —    | —    | —     | — | —    |
| 51-55             | —      | 2    | 4    | 1    | —    | —    | —    | —    | —    | —     | — | 5    |
| 56-60             | —      | —    | 4    | —    | —    | —    | —    | —    | —    | —     | — | 59   |
| 61-65             | —      | 12   | 1    | 8    | —    | 4    | —    | —    | —    | —     | — | 48   |
| 66-70             | —      | 1    | 78   | 7    | 1    | 4    | —    | —    | —    | —     | — | 229  |
| 71-75             | —      | 5    | 77   | 1    | 1    | 4    | —    | —    | —    | —     | — | 717  |
| 76-80             | 3      | 11   | 82   | 7    | 2    | 4    | —    | —    | —    | —     | — | 1004 |
| 81-85             | —      | 23   | 169  | 23   | 5    | 4    | —    | —    | —    | —     | — | 1768 |
| 86-90             | 3      | 35   | 119  | 12   | 5    | 2    | —    | —    | —    | —     | — | 671  |
| 91-95             | 23     | 58   | 182  | 17   | 2    | —    | —    | —    | —    | —     | — | 356  |
| 96-100            | 15     | 37   | 86   | 16   | 1    | —    | —    | —    | —    | —     | — | 186  |
| 101-105           | 23     | 15   | 48   | 5    | 1    | —    | —    | —    | —    | —     | — | 73   |
| 106-110           | 11     | 14   | 26   | 1    | —    | —    | —    | —    | —    | —     | — | 36   |
| 111-115           | —      | 5    | 9    | 4    | —    | —    | —    | —    | —    | —     | — | —    |
| 116-120           | —      | —    | 8    | —    | —    | —    | —    | —    | —    | —     | — | —    |
| 121-125           | —      | —    | 7    | 1    | —    | —    | —    | —    | —    | —     | — | —    |
| Mean size<br>(mm) | 93.2   | 86.6 | 91.8 | 86.5 | 77.5 | 90.3 | —    | —    | —    | —     | — | 96.5 |

period December 1971 to June 1973 at Ambalapuzha.

prawns per unit effort)

| Months        |      |      |      |      |      |       |       |      |
|---------------|------|------|------|------|------|-------|-------|------|
| 1973          |      |      |      |      |      |       |       |      |
| Oct.          | Nov. | Dec. | Jan. | Feb. | Mar. | Apr.  | May   | June |
| <b>Male</b>   |      |      |      |      |      |       |       |      |
| —             | —    | —    | —    | —    | —    | 344   | —     | —    |
| —             | 55   | 3    | —    | 85   | 304  | —     | 262   | —    |
| —             | 697  | 2    | —    | 183  | 584  | 2155  | 431   | 0.05 |
| 38            | 1878 | 13   | 2    | 209  | 1626 | 4174  | 1117  | 0.37 |
| 132           | 1910 | 27   | 1    | 526  | 1973 | 3673  | 2364  | 0.46 |
| 441           | 3738 | 59   | 3    | 707  | 6511 | 13004 | 3999  | 2.6  |
| 488           | 2850 | 59   | 7    | 1078 | 4249 | 10798 | 4223  | 4    |
| 349           | 2615 | 55   | 4    | 1019 | 3872 | 5184  | 3588  | 1    |
| 116           | 1114 | 15   | 3    | 322  | 2051 | 5185  | 1521  | 1    |
| 91            | 93   | —    | —    | 39   | —    | 2772  | 709   | 0.05 |
| 306           | —    | 3    | —    | —    | —    | 8044  | —     | 0.4  |
| —             | —    | —    | —    | —    | —    | 8044  | —     | —    |
| —             | —    | —    | —    | —    | —    | 4022  | —     | —    |
| 81.1          | 74.8 | 80.8 | 77.4 | 76.0 | 75.3 | 90.9  | 76.3  | 78.7 |
| <b>Female</b> |      |      |      |      |      |       |       |      |
| —             | —    | —    | —    | —    | —    | —     | —     | —    |
| —             | 188  | —    | —    | 25   | 128  | 1158  | —     | 0.05 |
| —             | —    | —    | 1    | 90   | 945  | 1378  | 367   | 0.5  |
| 17            | 95   | —    | 2    | 118  | 927  | 1080  | 1227  | 2    |
| 82            | 332  | 11   | 2    | 608  | 2946 | 3679  | 1971  | 4    |
| 312           | 4596 | 18   | 3    | 1009 | 2461 | 10561 | 2982  | 3    |
| 309           | 9975 | 36   | 8    | 1140 | 7298 | 11340 | 16939 | 3    |
| 90            | 1870 | 65   | 12   | 1450 | 9524 | 4092  | 8267  | 3    |
| 391           | 1359 | 25   | 3    | 1058 | 3145 | 19443 | 5402  | 1    |
| 233           | 796  | 2    | 3    | 727  | 4293 | 13254 | 2992  | 0.5  |
| 285           | —    | 2    | 1    | 744  | 3384 | 49478 | 1728  | 0.05 |
| 65            | —    | —    | 2    | 285  | 1632 | 4948  | 211   | 0.04 |
| 34            | —    | —    | 1    | 25   | —    | 2746  | 379   | 0.07 |
| —             | —    | —    | —    | 39   | 179  | 1249  | —     | —    |
| —             | —    | —    | —    | —    | —    | 186   | —     | —    |
| —             | —    | —    | —    | —    | —    | —     | —     | —    |
| 84.6          | 85.0 | 76.2 | 82.8 | 83.6 | 82.6 | 99.4  | 80.9  | 74.6 |

TABLE 5. Size distribution of *P. indicus* during the  
(Figures denote number of

| Size in<br>(mm)   | Months       |              |       |       |       |       |      |       |       |       |
|-------------------|--------------|--------------|-------|-------|-------|-------|------|-------|-------|-------|
|                   | 1971<br>Dec. | 1972<br>Jan. | Feb.  | Mar.  | Apr.  | May   | June | July  | Aug.  | Sept. |
| Male              |              |              |       |       |       |       |      |       |       |       |
| 96-100            | —            | 0.08         | 0.1   | 2.4   | 1.3   | —     | —    | —     | —     | —     |
| 101-105           | —            | 0.1          | 0.5   | —     | —     | —     | —    | —     | —     | —     |
| 106-110           | —            | 0.08         | 1.9   | —     | 2.2   | —     | —    | 0.01  | —     | —     |
| 111-115           | —            | 0.05         | 1.6   | 1.2   | 7.7   | —     | —    | —     | —     | —     |
| 116-120           | —            | 0.05         | 0.5   | —     | 2.1   | —     | —    | —     | —     | —     |
| 121-125           | —            | 0.08         | 3.6   | 1.6   | 4.1   | —     | —    | —     | 0.04  | —     |
| 126-130           | —            | 0.6          | 1.5   | 7.5   | 17.0  | —     | —    | —     | 0.04  | —     |
| 131-135           | —            | 0.04         | 5.4   | 4.2   | 22.0  | 0.2   | —    | —     | 0.07  | —     |
| 136-140           | —            | 0.04         | 6.8   | 8.0   | 34.0  | 0.2   | —    | —     | 0.2   | —     |
| 141-145           | —            | —            | 6.3   | 13.9  | 27.0  | 0.6   | —    | —     | 0.4   | —     |
| 146-150           | —            | —            | 3.1   | 18.3  | 34.3  | 0.6   | —    | —     | 0.4   | —     |
| 151-155           | —            | —            | 0.09  | 2.0   | 31.1  | 1.2   | —    | —     | —     | —     |
| 156-160           | —            | —            | —     | 2.8   | 13.3  | 0.7   | —    | —     | 0.2   | —     |
| 161-165           | —            | —            | —     | 2.4   | 32.1  | 1.5   | —    | —     | 0.2   | —     |
| 166-170           | —            | —            | —     | —     | —     | 0.2   | —    | —     | —     | —     |
| 171-175           | —            | —            | —     | —     | —     | —     | —    | —     | —     | —     |
| Mean size<br>(mm) | —            | 125.8        | 126.6 | 140.1 | 142.0 | 145.7 | —    | 113.0 | 145.4 | —     |
| Female            |              |              |       |       |       |       |      |       |       |       |
| 96-100            | —            | 0.3          | —     | 0.9   | —     | —     | —    | —     | —     | —     |
| 101-105           | —            | —            | 0.1   | 0.6   | 4.3   | —     | —    | —     | —     | —     |
| 106-110           | —            | 8.5          | 0.6   | 1.4   | 0.9   | —     | —    | 0.2   | —     | —     |
| 111-115           | —            | 5.2          | 0.3   | —     | 0.9   | —     | —    | 0.2   | —     | —     |
| 116-120           | —            | 0.5          | 1     | 0.9   | 9.2   | —     | —    | 0.2   | —     | —     |
| 121-125           | —            | 0.6          | 5.1   | 2.5   | 21.0  | —     | —    | 0.6   | —     | —     |
| 126-130           | —            | 1.1          | 2.3   | 3.5   | 20.0  | —     | —    | 0.7   | 0.07  | —     |
| 131-135           | —            | 0.5          | 1.8   | 12.5  | 5.7   | —     | —    | 0.2   | —     | —     |
| 136-140           | —            | 0.5          | 1.9   | 5.0   | 44.1  | —     | —    | 0.2   | 0.1   | —     |
| 141-145           | —            | 1.9          | 6.6   | 21.4  | 97.6  | 0.4   | —    | 0.2   | 0.2   | —     |
| 146-150           | —            | —            | 9.1   | 20.8  | 60.0  | 0.2   | —    | —     | 0.9   | —     |
| 151-155           | —            | 0.02         | 6.0   | 0.6   | 34.4  | 1.7   | —    | —     | 0.7   | —     |
| 156-160           | —            | —            | —     | 1.4   | 35.0  | 1.5   | —    | —     | 0.7   | —     |
| 161-165           | —            | —            | —     | 3.1   | 74.9  | 1.3   | —    | —     | 0.3   | —     |
| 166-170           | —            | —            | —     | 2.8   | 15.6  | 0.4   | —    | —     | 0.1   | —     |
| 171-175           | —            | —            | —     | —     | —     | —     | —    | —     | —     | —     |
| Mean size<br>(mm) | —            | 117.6        | 139.0 | 141.3 | 140.1 | 121.2 | —    | 130.9 | 150.2 | —     |



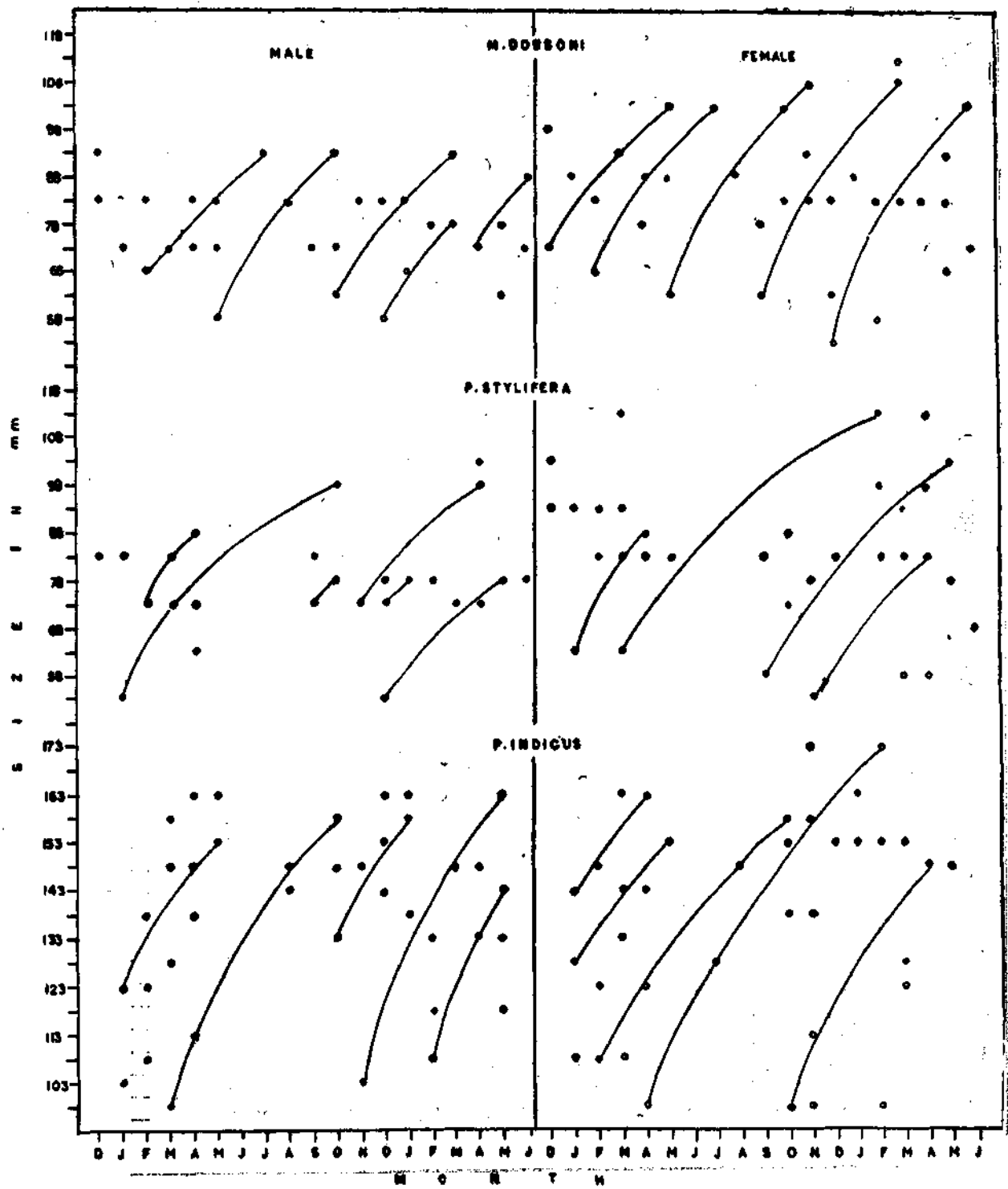


FIG. 1. Modal size distribution and growth curves of three species of penaeid prawns at Ambalapuzha.

● Main modes    ○ Subsidiary modes

To find out the pattern of growth of these species, the monthly mode chains presented in Table 6 were analysed further, following the methods described by Gulland (1969). The average rate of growth  $\frac{l_2 - l_1}{t_2 - t_1}$  was plotted against  $\frac{l_1 - l_2}{2}$  where  $l_1$  and  $l_2$  are the lengths at times  $t_1$  and  $t_2$  respectively. This gave a linear relationship and could be taken as an approximation to the straight line,

$$\frac{dl}{dt} = K \left( \frac{L-l}{\alpha} \right),$$

where  $\frac{L}{\alpha}$  is the maximum expected length and  $K\alpha$ , growth coefficient. The slope of the line gives an estimate of  $K$  and the intercept on X-axis, an estimate of  $\frac{L}{\alpha}$ . The growth in length of these species could then be expressed by the well-known von Bertalanffy equation (Beverton, 1954),

$$L_t = \frac{L}{\alpha} (1 - e^{-K(t-t_0)})$$

where  $t_0$  = the theoretical age at which  $l = 0$ .

' $t_0$ ' was estimated by fitting a regression line of  $\log_e (L\alpha - lt)$  on ' $t$ '. The intercept on the Y-axis of this straight line is

$$a = \log_e L\alpha + Kt_0$$

giving

$$t_0 = \frac{a - \log_e L\alpha}{K}$$

The calculated values for  $L$ ,  $K$  and  $t_0$  for each species are given in Table 7. Substituting these figures in the above equation, the size of each of the species at different ages was estimated and shown in Fig. 2. The sex-wise length of each species at the age 6, 12, 18 and 24 months is given in Table 8.

The growth rates obtained from the actual observation of the progression of modal sizes in the monthly length frequency distribution of *M. dobsoni* (Table 6) and from the Von Bertalanffy's equation indicate that the females of the species grow faster than males throughout their life. Although a similar differential growth between the sexes is evident in *P. stylifera* also, it is interesting to note that the males during their earlier life (for about 4 months) grow at a much faster rate than the females and thereafter, their growth rate is reduced considerably. Unlike the above two species, the males of *P. indicus* grow throughout their life at a faster rate than the females. Based on the

TABLE 6: Progress of size modes and rate of growth in three species of penaeid prawns at Ambalapuzha.

| Initial mode (mm)         | Progression of modes |                 | Month          | Growth increment (mm) | Duration in month | Average rate of growth month (mm) |
|---------------------------|----------------------|-----------------|----------------|-----------------------|-------------------|-----------------------------------|
|                           | Month                | Final mode (mm) |                |                       |                   |                                   |
| <i>M. dobsoni</i> Male    |                      |                 |                |                       |                   |                                   |
| 68                        | February, 1972       | 93              | July, 1972     | 25                    | 5                 | 5.0                               |
| 58                        | May, 1972            | 93              | October, 1972  | 35                    | 5                 | 7.0                               |
| 63                        | October, 1972        | 93              | March, 1973    | 30                    | 5                 | 6.0                               |
| 58                        | December, 1972       | 78              | March, 1973    | 20                    | 3                 | 6.6                               |
| 73                        | April, 1973          | 88              | June, 1973     | 15                    | 2                 | 7.5                               |
|                           |                      |                 |                | 125                   | 20                | 6.2                               |
| Female                    |                      |                 |                |                       |                   |                                   |
| 73                        | December, 1971       | 103             | May, 1972      | 30                    | 5                 | 6.0                               |
| 68                        | February, 1972       | 103             | July, 1972     | 35                    | 5                 | 7.0                               |
| 63                        | May, 1972            | 108             | November, 1972 | 45                    | 6                 | 7.5                               |
| 63                        | September, 1972      | 108             | March, 1973    | 45                    | 6                 | 7.5                               |
| 53                        | December, 1972       | 103             | June, 1973     | 50                    | 6                 | 8.3                               |
|                           |                      |                 |                | 205                   | 28                | 7.3                               |
| <i>P. styliifera</i> Male |                      |                 |                |                       |                   |                                   |
| 53                        | January, 1972        | 98              | October, 1972  | 45                    | 9                 | 5.0                               |
| 73                        | February, 1972       | 88              | April, 1972    | 15                    | 2                 | 7.5                               |
| 78                        | September, 1972      | 83              | October, 1972  | 5                     | 1                 | 5.0                               |
| 73                        | November, 1972       | 98              | April, 1972    | 25                    | 5                 | 5.0                               |
| 53                        | December, 1972       | 78              | May, 1972      | 25                    | 5                 | 5.0                               |
|                           |                      |                 |                | 115                   | 22                | 5.2                               |
| Female                    |                      |                 |                |                       |                   |                                   |
| 63                        | January, 1972        | 88              | April, 1972    | 25                    | 3                 | 8.3                               |
| 63                        | March, 1972          | 113             | February, 1973 | 48                    | 11                | 4.4                               |
| 58                        | September, 1972      | 103             | May, 1973      | 45                    | 8                 | 5.6                               |
| 53                        | November, 1972       | 83              | April, 1973    | 30                    | 5                 | 6.0                               |
| 58                        | April, 1973          | 68              | June, 1973     | 10                    | 2                 | 5.0                               |
|                           |                      |                 |                | 158                   | 29                | 5.4                               |
| <i>P. indicus</i> Male    |                      |                 |                |                       |                   |                                   |
| 123                       | January, 1972        | 153             | May, 1972      | 30                    | 4                 | 7.5                               |
| 103                       | January, 1972        | 138             | April, 1972    | 35                    | 3                 | 11.7                              |
| 98                        | March, 1972          | 158             | October, 1972  | 60                    | 7                 | 8.6                               |
| 103                       | November, 1972       | 163             | May, 1973      | 60                    | 6                 | 10.0                              |
| 108                       | February, 1972       | 143             | May, 1973      | 35                    | 3                 | 11.7                              |
| 133                       | October, 1972        | 158             | January, 1973  | 25                    | 3                 | 8.3                               |
|                           |                      |                 |                | 245                   | 26                | 9.8                               |
| Female                    |                      |                 |                |                       |                   |                                   |
| 128                       | January, 1972        | 153             | May, 1972      | 25                    | 4                 | 6.2                               |
| 108                       | February, 1972       | 158             | October, 1972  | 50                    | 8                 | 6.25                              |
| 98                        | April, 1972          | 173             | February, 1973 | 75                    | 10                | 7.5                               |
| 98                        | October, 1972        | 148             | April, 1973    | 50                    | 6                 | 8.3                               |
|                           |                      |                 |                | 200                   | 28                | 7.2                               |



TABLE 7. Growth parameters for the three species of penaeid prawns calculated from Von Bertalanffy growth equation

| Species             | Sex    | Growth parameters      |        |                |
|---------------------|--------|------------------------|--------|----------------|
|                     |        | L <sub>∞</sub><br>(mm) | K      | t <sub>0</sub> |
| <i>M. dobsoni</i>   | Male   | 128.9                  | 0.1268 | 0.9660         |
|                     | Female | 144.6                  | 0.1280 | 0.3946         |
| <i>P. stylifera</i> | Male   | 125.7                  | 0.1227 | 1.5996         |
|                     | Female | 130.1                  | 0.1395 | 1.4533         |
| <i>P. indicus</i>   | Male   | 193.9                  | 0.1551 | 0.6632         |
|                     | Female | 197.7                  | 0.1092 | 1.2864         |

TABLE 8. The estimated size of the three species of penaeid prawns at various age.

| Species             | Sex    | Age in months and the size (mm) attained |       |       |       |
|---------------------|--------|--|-------|-------|-------|
|                     |        | 6  | 12    | 18    | 24    |
| <i>M. dobsoni</i>   | Male   | 58.1                                     | 97.1  | 113.1 | 122.5 |
|                     | Female | 72.8                                     | 115.4 | 131.5 | 138.1 |
| <i>P. stylifera</i> | Male   | 63.3                                     | 91.4  | 108.7 | 117.2 |
|                     | Female | 65.5                                     | 98.0  | 114.2 | 122.9 |
| <i>P. indicus</i>   | Male   | 106.8                                    | 158.5 | 180.8 | 188.6 |
|                     | Female | 89.2                                     | 138.1 | 168.1 | 181.5 |

above observations on the age and growth and the maximum size obtained in the fishery, the life span of all these species can be considered to be about 2 years.

#### Age composition

On the basis of estimated size at different ages, the age composition of male and female population of each of the species is given in Table 9. In *M. dobsoni*, 7-12 month old prawns formed the bulk of the catch in all the months. Males 1-6 month old were abundant in the catches only during March-May 1973 and the females of that age from October to May. The males belonging to 13-18 months age group were found in appreciable numbers only in December 1971 and July 1972. The females of this age group were generally scarce in the fishery except in April-May 1973.

In *P. stylifera* also, the bulk of the catch was composed of 7-12 month old prawns. Males, 1-6 month old, were completely absent in the fishery during May-August 1972 and in June 1973, but they were well represented

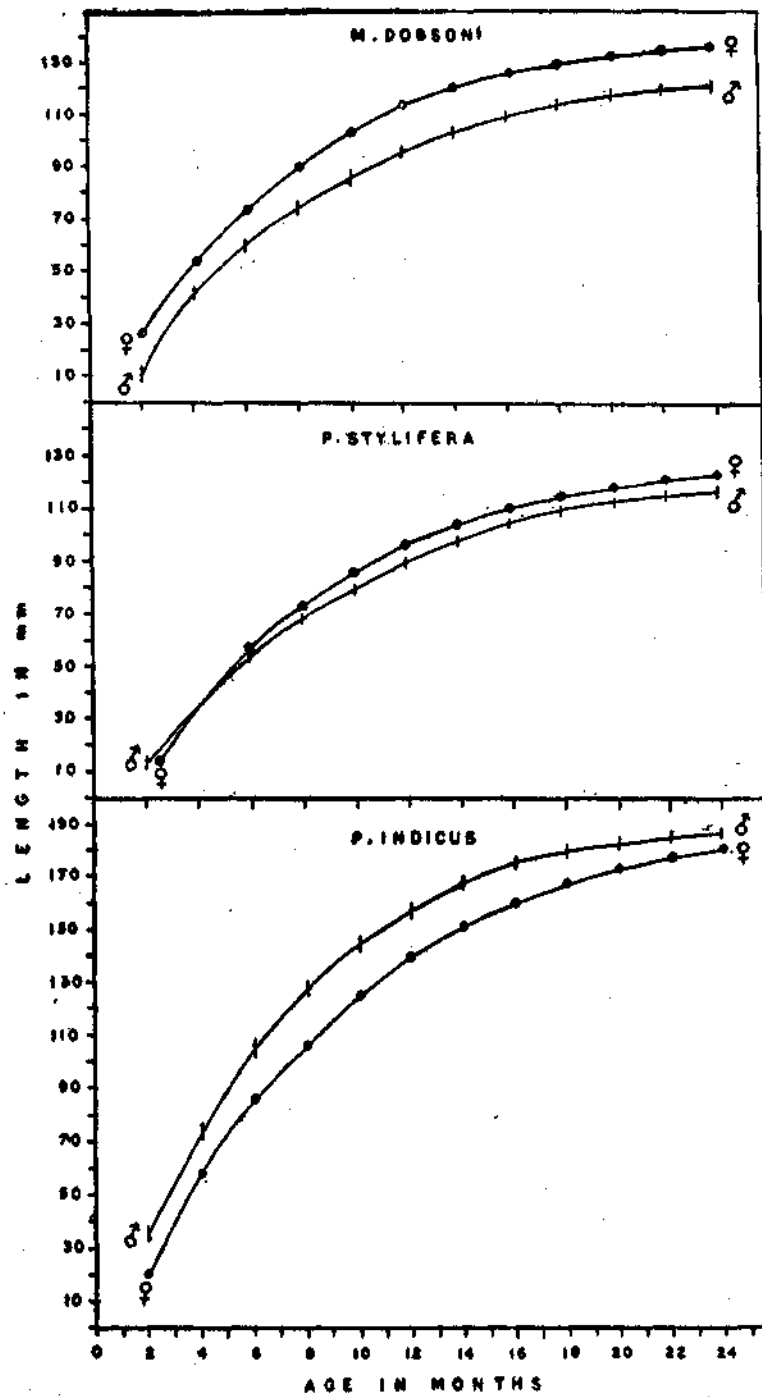


FIG. 2. Growth rate of three species of penaeid prawns fitted by Von Bertalanffy growth equation.

in November 1972 and March-May 1973. In April 1973 13-18 month old prawns were also caught in appreciable numbers. In females, the highest number of 1-6 month old prawns were caught in March-May 1973; 13-18 month old prawns in April 1973. 19-24 month old prawns did not contribute to the fishery except in February 1972 and April 1973.

*P. indicus* fishery was chiefly supported by the prawns belonging to 7-12 month age group in the case of males and 13-18 month old prawns in females. In most of the months, males 1-6 month old were poorly represented in the fishery, while 13-18 month old prawns were abundant in April 1972 and May 1973. In the latter month they contributed to the bulk of the catch. Females, 1-6 month old, were completely absent in the fishery. Although the prawns belonging to 7-12 month age group were well represented in the catches, they contributed to the major portion of the landings only in January and July 1972. Prawns, 19-24 month old, were caught in November and December 1972 and February, March and May 1973.

#### *Spawning*

*M. dobsoni* spawns throughout the year as indicated by the occurrence of mature females in all the months. The peak spawning is observed during April-June and October-December. Females spawning for the first time are encountered in appreciable numbers in the above periods. Although the spawners occur in all the size groups above 51 mm, majority of them are found between 76 mm and 100 mm size (Table 10), and they belong to O-year class.

The occurrence of mature females of *P. stylifera* in all the months confirms the earlier observations (George *et al.*, 1963; Rao, 1968) that the spawning in the population takes place throughout the year. During the period of present observation, intensive breeding of the species was recorded in October-December. Size-wise distribution of spawning females (Table 10) shows that greater number of spawners were generally encountered in the size group between 76 mm and 100 mm and they belong to O-year class. Females spawning for the first time and those belonging to the first year class are generally observed from October to June.

As in the case of the preceding two species, mature females of *P. indicus* were found in all the months, indicating a protracted spawning in the population. Peak spawning during the period of observation was recorded in April-June and October-December. Females spawning for the first time were encountered only in January and April 1972. Majority of the spawning population was found between 141-145 mm and 181-185 mm size group and they belonging to first year class.

#### *Recruitment*

Since all the species breed throughout the year, the recruitment of younger prawns into the fishery is also considered to be continuous. But the



*species of prawns at Ambalapuzha.*

number per unit of effort)

| Months              |       |       |       |              |       |        |        |        |      |
|---------------------|-------|-------|-------|--------------|-------|--------|--------|--------|------|
| Sept.               | Oct.  | Nov.  | Dec.  | Jan.<br>1973 | Feb.  | Mar.   | Apr.   | May    | June |
| <i>M. dobsoni</i>   |       |       |       |              |       |        |        |        |      |
| Male                |       |       |       |              |       |        |        |        |      |
| 13                  | 469   | 247   | 421   | —            | 67    | 4413   | 883    | 5120   | —    |
| 299                 | 12693 | 8295  | 8564  | 64           | 4135  | 254339 | 42527  | 66096  | 38   |
| —                   | —     | —     | —     | —            | —     | —      | —      | —      | 1    |
| Female              |       |       |       |              |       |        |        |        |      |
| 144                 | 3192  | 3138  | 3959  | 15           | 1327  | 18444  | 11620  | 17146  | 9    |
| 343                 | 29860 | 19940 | 32813 | 104          | 8249  | 360088 | 79174  | 121310 | 30   |
| —                   | —     | —     | —     | —            | —     | —      | 619    | 764    | 1    |
| <i>P. stylifera</i> |       |       |       |              |       |        |        |        |      |
| Male                |       |       |       |              |       |        |        |        |      |
| 315                 | 38    | 4530  | 18    | 2            | 477   | 2514   | 6673   | 1810   | —    |
| 1890                | 1617  | 12320 | 215   | 18           | 3691  | 18656  | 40616  | 16404  | 9    |
| —                   | 306   | —     | 3     | —            | —     | —      | 20110  | —      | —    |
| Female              |       |       |       |              |       |        |        |        |      |
| 112                 | 17    | 283   | —     | 3            | 233   | 2000   | 3616   | 1594   | 3    |
| 4931                | 1702  | 18928 | 159   | 32           | 6736  | 33051  | 111847 | 40281  | 15   |
| 109                 | 99    | —     | —     | 3            | 346   | 1811   | 8943   | 590    | 1    |
| —                   | —     | —     | —     | —            | —     | —      | 186    | —      | —    |
| <i>P. indicus</i>   |       |       |       |              |       |        |        |        |      |
| Male                |       |       |       |              |       |        |        |        |      |
| —                   | —     | 6.6   | —     | —            | 5.6   | 0.1    | 0.1    | —      | —    |
| —                   | 44.1  | 42.1  | 7.5   | 0.8          | 19.4  | 1.2    | 16.2   | 39.6   | —    |
| —                   | 10.8  | 3.9   | 1.4   | 0.2          | —     | —      | 0.4    | 121.5  | —    |
| Female              |       |       |       |              |       |        |        |        |      |
| —                   | —     | —     | —     | —            | —     | —      | —      | —      | —    |
| —                   | 34.2  | 78.8  | 1.96  | 0.09         | 23.4  | 2.8    | 3.0    | 15.6   | —    |
| —                   | 104.8 | 144.8 | 27.9  | 2.49         | 103.1 | 9.2    | 17.8   | 78.3   | —    |
| —                   | —     | 19.2  | 1.1   | —            | 3.5   | 0.1    | —      | 3.4    | —    |

TABLE 10. *Size-wise distribution of mature females of three species of penaeid prawns during January 1972 to June 1973.*

(Numbers are given in thousands)

| Period               | Size range (mm) |          | 101-125 | Total (%)          |
|----------------------|-----------------|----------|---------|--------------------|
|                      | 51-75           | 76-100   |         |                    |
| <i>M. dobsoni</i>    |                 |          |         |                    |
| 1972 January — March | 147.4           | 2135.2   | 176.6   | 2459.2<br>(31.5)   |
| April — June         | 80.9            | 5093.7   | 1007.1  | 6181.7<br>(64.0)   |
| July — September     | 6.7             | 2549.9   | 8557.3  | 11113.9<br>(43.5)  |
| October — December   | 11391.4         | 298618.4 | 39545.1 | 349554.9<br>(46.2) |
| 1973 January — March | 6488.8          | 146497.7 | 9016.4  | 162002.9<br>(43.1) |
| April — June         | 17335.9         | 118256.7 | —       | 135592.6<br>(21.6) |
| <i>P. stylifera</i>  |                 |          |         |                    |
| 1972 January — March | 67.9            | 1085.9   | 352.6   | 1506.4<br>(32.8)   |
| April — June         | 2.8             | 64.5     | —       | 67.3<br>(23.6)     |
| July — September     | 262.6           | 3171.5   | 229.8   | 3663.9<br>(34.7)   |
| October — December   | 573.9           | 15402.3  | 2450.1  | 18426.3<br>(37.9)  |
| 1973 January — March | 625.6           | 32167.7  | 5059.7  | 37853.0<br>(35.2)  |
| April — June         | 626.8           | 45611.0  | 8314.1  | 54551.9<br>(18.3)  |
| <i>P. indicus</i>    |                 |          |         |                    |
|                      | 101-125         | 126-150  | 151-175 | Total (%)          |
| 1972 January — March | 4.2             | 1462.2   | 35.5    | 1501.9<br>(31.7)   |
| April — June         | 72.0            | 1390.7   | 1075.5  | 2538.2<br>(68.7)   |
| July — September     | —               | 2.7      | 1.6     | 4.3<br>(45.8)      |
| October — December   | —               | 271.0    | 608.4   | 879.4<br>(47.3)    |
| 1973 January — March | —               | 31.7     | 95.1    | 126.8<br>(36.3)    |
| April — June         | —               | 8.5      | 153.8   | 162.3<br>(52.7)    |

smaller prawns below 50 mm size in the case of *M. dobsoni* and *P. stylifera* and below 95 mm size in *P. indicus* are not caught by the gears operated during the period, and hence the present data do not show a clear picture of the recruitment of younger prawns into the fishery. However, the length frequency distribution of *M. dobsoni* (Table 3) shows the recruitment of juveniles of both males and females into the fishery in February 1972 and from October 1972 to May 1973, the peak being April-May 1973. In *P. stylifera*, 3 peaks of recruitment — January-March 1972, November 1972 and March-April 1973 — are recorded during the period of observation. These recruits probably belong to the prawns spawned during October-December 1971; May 1972 and October-December 1972.

The recruitment of small sized *P. indicus* into the fishery was recorded during January-April of both the years. In the case of females, a secondary period of recruitment was also seen in October-November 1972.

#### Mortality

It is well known that the capture fishery for all these species except *P. stylifera* is carried out in two distinct environment namely, in the estuaries as well as backwaters, and in the marine region. In the marine fishery, *M. dobsoni* and *P. stylifera* appear in the catches when they attain a length of 50-60 mm and *P. indicus* at a size of 96-100 mm and are above 6 months old. Thus all these species are available for capture for the remaining  $1\frac{1}{2}$  years of their life.

The annual total mortality rate of these species for the year 1972 is estimated by using the following equation (Ssentongo and Larkin, 1973):

$$Z = K \left( \frac{n}{n+i} \right) \left( \frac{i}{\bar{y} - y_c} \right)$$

where Z = estimated annual total mortality rate,

n = the sample size,

$\bar{y}$  = the mean of the y's calculated for each month by the formula

$y = -\ln\left(1 - \frac{lt}{L_c}\right)$ , where 'lt' is the mean size of the population in a given month,

$y_c = -\ln\left(1 - \frac{lt}{L_c}\right)$ , where 'lc' is the length of the prawn at first capture, and

K = the growth coefficient obtained from Von Bertalanffy growth equation.

The annual total mortality rate obtained for each sex of the species is given in Table 11. Higher mortality rate of about 4 was found in the males of *M. dobsoni* and *P. stylifera*. In the case of the females of these species

as well as in the males of *P. indicus* it was slightly lower, being about 3. The lowest mortality rate (2.1) was obtained for the females of *P. indicus*.

TABLE 11. The total mortality rates of three species of penaeid prawns for the year 1972 at Ambalapuzha.

| Species              | Sex    | K      | n*     | lc<br>(mm) | $\bar{y}$ | yc     | Z   |
|----------------------|--------|--------|--------|------------|-----------|--------|-----|
| <i>M. dobsoni</i>    | Male   | 1.5216 | 3242.8 | 52.0       | 0.9264    | 0.5165 | 3.8 |
|                      | Female | 1.5360 | 6028.1 | 51.0       | 0.9313    | 0.4349 | 3.1 |
| <i>P. styliifera</i> | Male   | 1.4724 | 1155.7 | 48.0       | 0.8493    | 0.4811 | 3.9 |
|                      | Female | 1.6740 | 2179.0 | 52.0       | 1.0940    | 0.5101 | 2.9 |
| <i>P. indicus</i>    | Male   | 1.8612 | 8.4    | 98.0       | 1.2856    | 0.6846 | 3.1 |
|                      | Female | 1.3104 | 22.7   | 97.0       | 1.2855    | 0.6745 | 2.1 |

\* estimated number of prawns in lakhs.

#### EXPLOITATION

The estimated total catch of prawns during the period December 1971 to December 1973 amounted to 8454.9 tonnes, of which 35.3% was contributed by the mechanised boats with trawl nets and the rest by the non-mechanised boats with 'Thangu vala'. Better prawn catches by the trawl net fishery were generally realised in April-May and November-December. In the indigenous fishery, however, the highest catch was observed in July (Table 12).

*M. dobsoni* contributing to 54.4% of the overall prawn landings by trawl nets, dominates in the catches in May and October to December. In the indigenous fishery, maximum exploitation of the species is observed in July, when vast shoals congregate very near the shore. The peak fishing season for *P. styliifera* extends from February to April, although, appreciable quantities were also landed in November. The highest catch rate for the species was recorded in February 1972. In the indigenous fishery, the species is scarce and is generally absent from July to August. Maximum abundance of *P. indicus* is found in April-May.

#### DISCUSSION

The catch of penaeid prawns at Ambalapuzha is predominantly composed of females, although in *M. dobsoni* and *P. styliifera*, males are found in higher proportion in the lower size groups. This observation differs from that of Menon (1957) for the inshore fishery of these species at Narakkal during 1952-55, when he recorded the preponderance of males in the population as well as among those measuring up to 100 mm size. George *et al.* (1963) found that the females of all these species except *P. indicus*, generally dominate in the offshore prawn catches off Cochin, while George and Rao (1967) studying the sex ratio distribution of these species in the same ground, showed that



TABLE 12. Estimated total fishing effort, estimated total catch and catch per unit of effort for prawns at Ambalapuzha during December 1971 to December 1973.

(Data given in the box pertain to the fishery by non-mechanised boats with 'Thanguvala').

| Month                    | Total fishing effort (hrs) | Total catch (tonnes) |                     |                   | Catch/unit of effort (kgs) |                     |                   | % of prawns in total fish catch |      |
|--------------------------|----------------------------|----------------------|---------------------|-------------------|----------------------------|---------------------|-------------------|---------------------------------|------|
|                          |                            | <i>M. dobsoni</i>    | <i>P. stylifera</i> | <i>P. indicus</i> | <i>M. dobsoni</i>          | <i>P. stylifera</i> | <i>P. indicus</i> |                                 |      |
| 1971                     | December                   | 18600                | 54.3                | 33.8              | —                          | 2.9                 | 1.8               | —                               | 68.4 |
| 1972                     | January                    | 20646                | 19.3                | 26.7              | 2.9                        | 0.93                | 1.3               | 1.4                             | 43.8 |
|                          | February                   | 17947                | 58.9                | 97.6              | 27.3                       | 3.3                 | 5.4               | 1.5                             | 70.6 |
|                          | March                      | 34560                | 121.3               | 100.7             | 125.0                      | 3.5                 | 2.9               | 3.6                             | 81.3 |
|                          | April                      | 37971                | 30.9                | 11.6              | 384.8                      | 0.81                | 3.1               | 10.1                            | 87.4 |
|                          | May                        | 30587                | 463.8               | 9.9               | 24.8                       | 15.2                | 0.3               | 0.8                             | 91.8 |
|                          | June                       | —                    | —                   | —                 | —                          | —                   | —                 | —                               | —    |
|                          | July                       | 62961                | 1169.5              | —                 | 0.5                        | 18.6                | —                 | 0.007                           | 49.6 |
|                          | August                     | 5554                 | 0.4                 | —                 | 0.6                        | 0.07                | —                 | 0.1                             | 5.2  |
|                          | September                  | 6990                 | 3.3                 | 12.6              | —                          | 0.5                 | 1.8               | —                               | 32.5 |
|                          | October                    | 17484                | 94.1                | 11.9              | 8.9                        | 5.4                 | 0.68              | 0.51                            | 79.1 |
|                          | November                   | 26982                | 153.6               | 97.7              | 7.5                        | 5.6                 | 3.6               | 0.3                             | 89.7 |
|                          | December                   | 27582                | 222.0               | 6.4               | 14.9                       | 8.0                 | 0.2               | 0.05                            | 83.1 |
| 1973                     | January                    | 3210                 | 3.3                 | 0.8               | 0.4                        | 1.0                 | 0.3               | 0.1                             | 50.3 |
|                          | February                   | 13803                | 30.4                | 10.8              | 2.3                        | 2.2                 | 0.8               | 0.2                             | 58.6 |
|                          | March                      | 10435                | 26.8                | 8.8               | 0.9                        | 2.6                 | 0.8               | 0.09                            | 72.3 |
|                          | April                      | 3210                 | 3.3                 | 0.9               | 3.3                        | 1.0                 | 0.3               | 1.02                            | 50.4 |
|                          | May                        | 15176                | 51.6                | 14.5              | 32.0                       | 3.4                 | 0.9               | 2.1                             | 69.9 |
|                          | June                       | 9096                 | 4.2                 | 2.1               | —                          | 2.5                 | 0.2               | —                               | 11.9 |
|                          | July                       | 13821                | 4230.6              | —                 | —                          | 30.6                | —                 | —                               | 69.6 |
|                          | August                     | 16205                | 32.3                | —                 | —                          | 1.9                 | —                 | —                               | 8.2  |
|                          | September                  | —                    | —                   | —                 | —                          | —                   | —                 | —                               | —    |
|                          | October                    | 5887                 | 11.9                | 1.3               | 2.3                        | 2.0                 | 0.2               | 0.08                            | 4.5  |
|                          | November                   | 18413                | 141.2               | 2.8               | 2.4                        | 7.6                 | 0.15              | 0.13                            | 55.8 |
|                          | December                   | 34800                | 149.0               | 7.5               | 1.9                        | 4.2                 | 0.2               | 0.05                            | 67.2 |
| Total:                   |                            |                      |                     |                   |                            |                     |                   |                                 |      |
| For mechanised boats     |                            | 331406               | 1623.8              | 722.3             | 639.3                      | 4.9                 | 2.2               | 1.9                             | 69.9 |
| For non-mechanised boats |                            | 120514               | 5452.2              | 13.9              | 3.4                        | 45.2                | 0.1               | —                               | 25.9 |

the two sexes were distributed in greater patchiness in different months than expected by binomial theory (1:1 ratio) and that the ratio of males was high in the fishing ground during October-December. These authors attributed this different sex ratio to the movements of prawns associated with the breeding. While the preponderance of females in the population can be linked with the reproductive activities of these species, it is evident that the disparity in the sex ratio found in the different size groups is also influenced by the differential growth between the sexes.

Several workers have studied the age and growth of these species. Based on the rearing experiments carried out in the laboratory on juvenile prawns and on the length frequency studies of the commercial catches of *M. dobsoni* Menon (1951, 1954, 1955) recorded one-year old prawns measuring about 70 mm in males and 75-80 mm in females; two-year olds, 90-95 mm in males and 100-105 mm in females and three-year olds, above 100 mm in males and 120 mm in females. Later, George *et al.* (1963) and Banerji and George (1967) recorded a faster rate of growth and found that the species attains a size of about 90-95 mm in the first year of life, and 115 mm in the 2nd year. In the case of *P. stylifera* Menon (1953) observed that one-year old prawns attain a length of 90-100 mm, while Mohamed (1967) opined that this size is reached when the prawns are about 9 months old. According to George *et al.* (1963), *P. indicus* measuring 126-130 mm in males and 141-145 mm in females represent the one-year old group, those at 161-165 mm in males and 171-175 mm in females the two-year old group and those above 195 mm the three-year old group. In all these species differential growth rate for sexes, the females showing faster rate of growth than the males in *M. dobsoni* and *P. stylifera* and males growing faster than females in *P. indicus*, has been well established. In the present study, based on the progression of modal sizes in the monthly length frequency distribution and applying Von Bertalanffy growth equation, it has been shown that all the species grow at a much faster rate at Ambalapuzha than hitherto recorded. The present study shows that males and females of *M. dobsoni*, *P. stylifera* and *P. indicus* respectively attain a length of 97|115 mm; 91|98 mm and 158|138 mm at the end of first year and 122|138 mm; 117-123 mm and 189|181 mm at the end of second year of life and thus all these species have a life span of about 2 years. The results presented here have also revealed that among the three species, the highest difference in the growth rate between the sexes is found in *P. indicus* and the lowest in *P. stylifera*.

The bulk of the commercial fishery of *M. dobsoni* and *P. stylifera* is mainly supported by the 7-12 month old prawns and that of *P. indicus* by the 7-18 month old prawns. Similarly, the major portion of the spawning population of the females of the former two species is composed of 0-year old prawns and of the latter species by the one-year old groups. It has also been shown that the mortality rates of these species are relatively high. These indicate

that the fishable life span of these species is only about one or one and half years and that the fishery of a particular year largely depends on the prawns recruited during that year.

Although, variations in the monthly prawn landings and in the catch per unit of effort of prawns are apparent (Table 12), these data do not show a regular declining trend indicating that the fluctuation in the landings cannot be attributed to the effect of fishing. The distribution of mean size of all the species in different months also supports this view. However, since the quality and the quantity of the fishery, as discussed earlier, depend on the population which is replenished every year by surviving spawners and the subsequent recruitment of 0-year old prawns into the fishable stock, it is apparent that these biological features greatly cause the fluctuations in the landings.

Ecological changes brought out by the physico-chemical disturbances in the environment also influence the prawn landings in the area. This is more apparent in the southwest monsoon period when large numbers of prawns, particularly *M. dobsoni* and *P. indicus*, are seen to congregate very near the shore in the mud-bank areas. Although, the hydrological and ecological factors responsible for bringing out this lucrative fishery in the mud-bank region have been discussed by Banse (1959), George (1961) and George *et al.* (1968), the reasons for the wide fluctuations in the landings observed in different years and for the occurrence of large shoals of *P. indicus* only in certain years are not fully understood.

The effect of intensive trawling which disturbs the habitat by stirring up the fine sediment of the ground, on the availability of prawns has been pointed out by Slack-Smith (1969). To discuss the problem in the case of the trawl fishery of Ambalapuzha further data are necessary, although, it is known that similar disturbances of the grounds do occur during the mud-bank formation and the prawns during this period are not encountered in their usual bottom habitat, but in the columnar pelagic zone.

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